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(54) Abstract Title

Modelling a porous fractured geological medium

(57) A method providing a simplified approach to modelling a porous, heterogeneous geological medium (e.g. an oil reservoir crossed by an irregular fracture network) in the form of a transposed or equivalent medium equivalent to the original medium as regards a given physical transfer function consists in: a) forming an image of the original geological medium in at least two dimensions in the form of an array of pixels and associating a specific initial value to each pixel for this function, b) determining step by step values for the physical transfer function to be attributed to each pixel (e.g. the minimum distance separating the pixel from the nearest fracture) by reference to the function values attributed to adjacent pixels and c) determining a physical property of the transposed or equivalent medium by identifying the transfer function values known for the transposed medium with the transfer function values of the original medium determined step by step. The physical transfer function may represent variations between different parts of the geological medium, e.g. distances or transmissivities or thermal transfers (e.g. between a reservoir and a well crossing through the reservoir).

Application to determining a transposed medium giving the same recovery of a fluid during a capillary imbibation process as the real medium.

GB 2 322 949 A

FIG.1

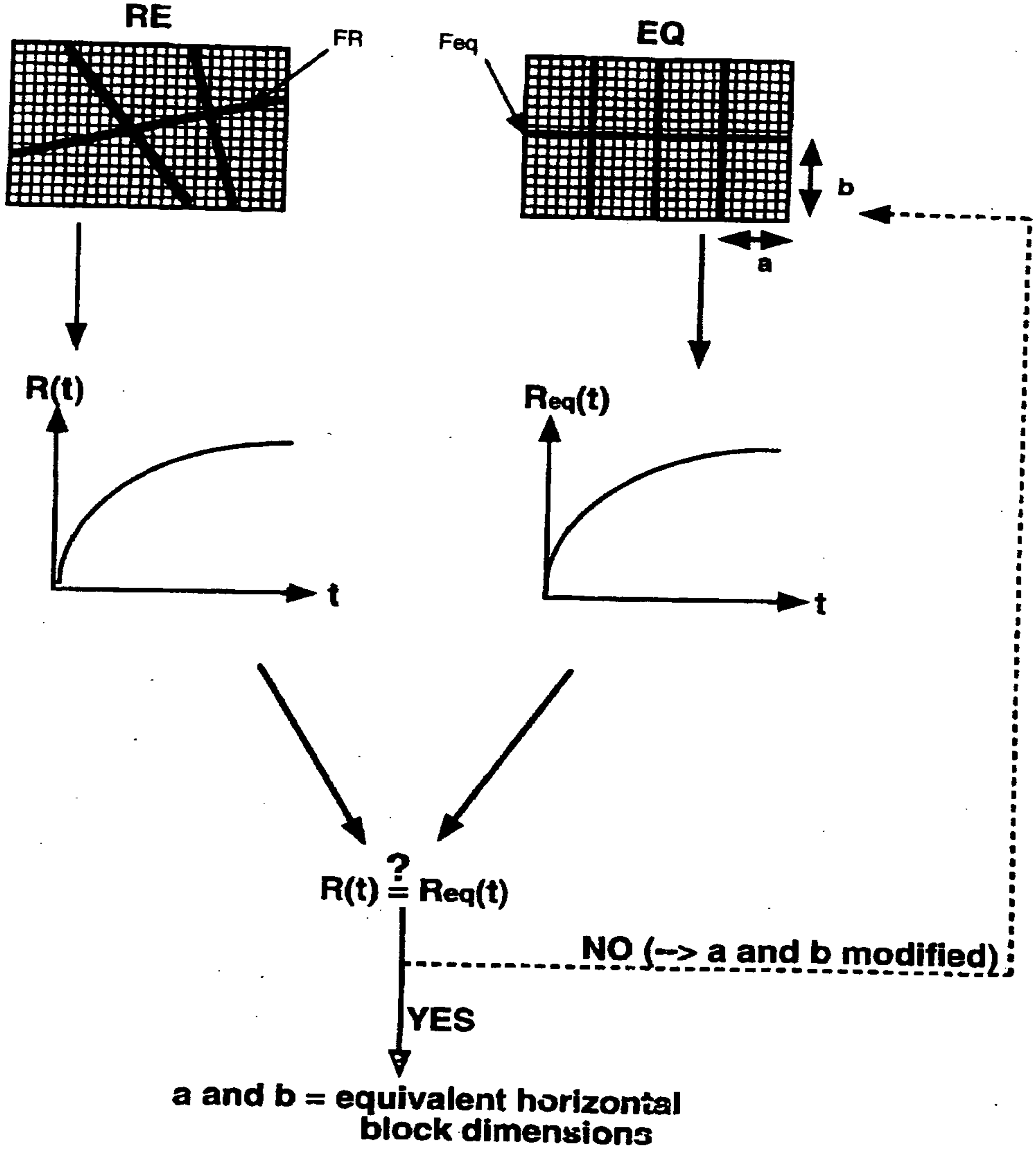

RE
FR
Feq
EQ
b
a
R(t)
t
Req(t)
t
R(t) ?= Req(t)
NO (--> a and b modified)
YES
a and b = equivalent horizontal block dimensions

FIG.2

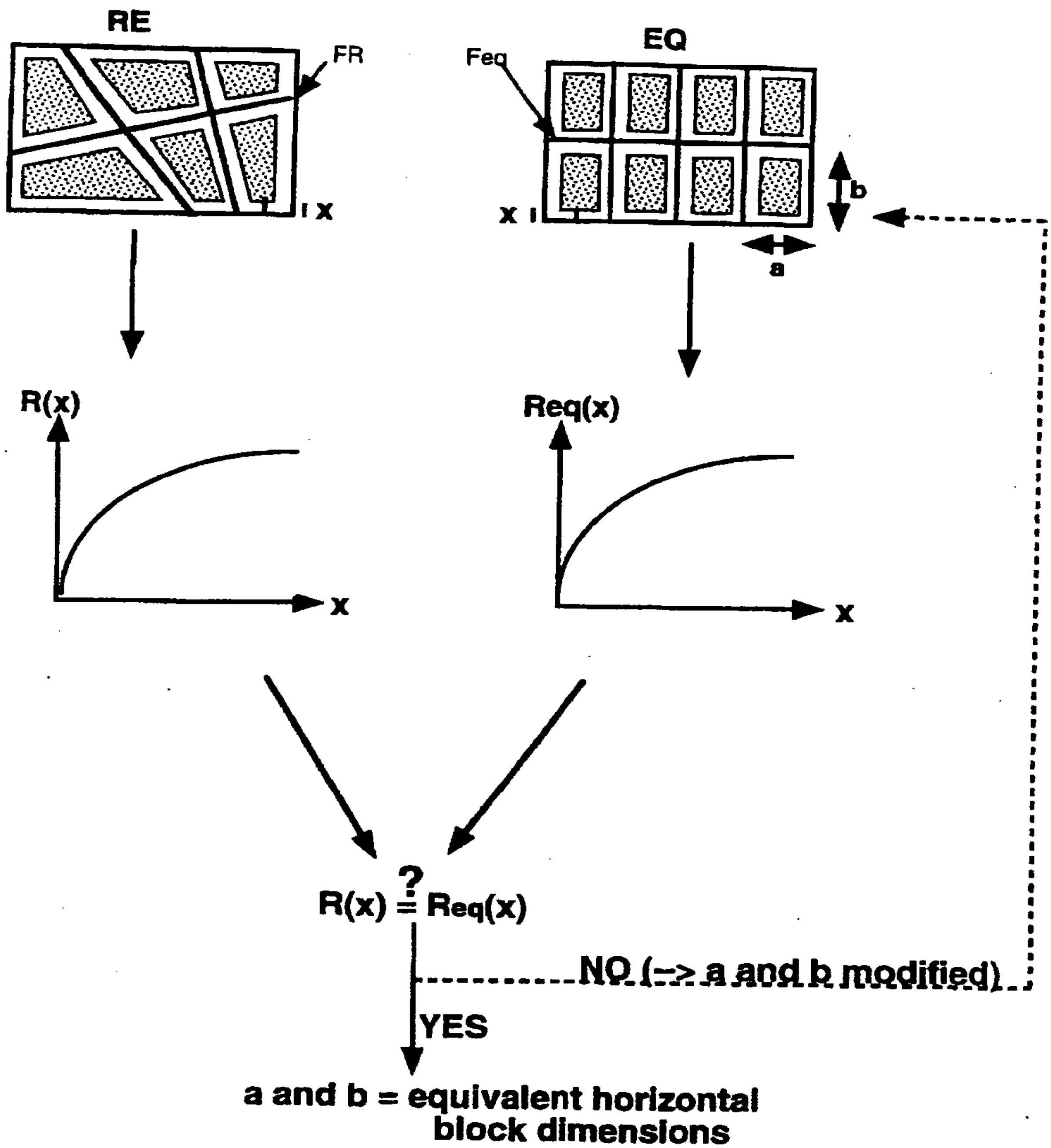
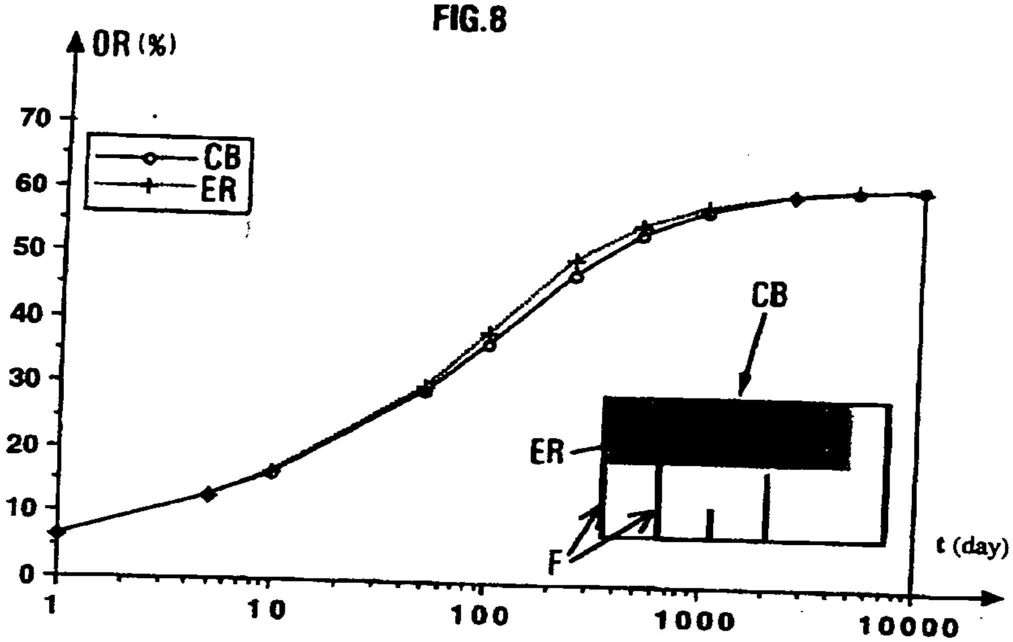
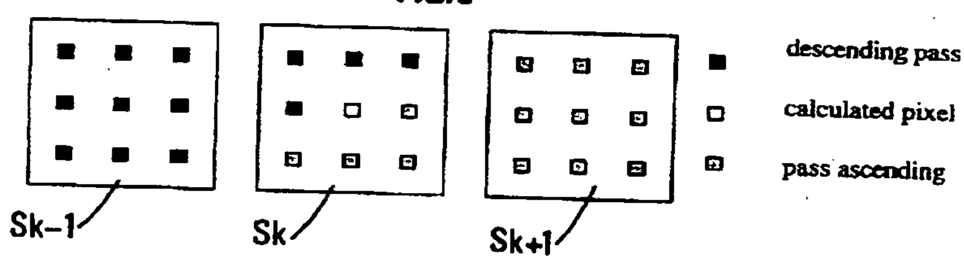

RE
FR
x
EQ
Feq
x
b
a
R(x)
x
Req(x)
x
R(x) ?= Req(x)
NO (--> a and b modified)
YES
a and b = equivalent horizontal block dimensions

FIG.8



OR (%)
70
60
50
40
30
20
10
0
CB
ER
CB
ER
F
1
10
100
1000
10000
t (day)

FIG.6



descending pass
calculated pixel
pass ascending
Sk-1
Sk
Sk+1

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METHOD OF SIMPLIFYING THE TASK OF MODELLING A POROUS GEOLOGICAL MEDIUM CROSSED BY AN IRREGULAR FRACTURE NETWORK

The invention relates to a method designed to simplify the task of modelling a porous geological medium crossed by an irregular network of fissures, which makes it easier to correlate the characterisation of fractured reservoirs with dual-porosity models. The method may be used by reservoir engineers in oil production, for example, in order to produce reliable flow predictions.

Fractured reservoirs are an extreme type of heterogeneous reservoirs made up of two contrasting media, a matrix medium containing the majority of the oil and of a low permeability and a fractured medium accounting for less than 1% of the oil in place and highly conductive. The fractured medium itself may be very complex having different fracture sets, each characterised by its density, length, orientation, tilt and aperture. 3D images of fractured reservoirs can not be used directly in the form of input data for simulating a reservoir. It has long been considered unrealistic to represent fracture networks within reservoir flow simulators because the layout of the network is partially unknown and because of the numerical limitations inherent in juxtaposing numerous

cells of extremely contrasting sizes and properties. A simplified but realistic way of modelling such media would therefore be of great interest to reservoir engineers.

The "dual porosity approach", as taught, for example, by Warren J.E. et al in "The Behaviour of Naturally Fractured Reservoirs", SPE Journal (September 1963), 245-255, is known in the art as a means of interpreting single-phase flow behaviour observed when testing a fractured reservoir. In accordance with this basic model, any elementary volume of the fractured reservoir is modelled in the form of a set of identical parallelepipedic blocks limited by an orthogonal system of continuous uniform fractures oriented in the direction of one of the three main flow directions. On the reservoir scale, fluid flows through the fractured medium only and fluid exchanges occur locally between the fissures and the matrix blocks.

Numerous simulators have been developed for fractured reservoirs using a model of this type with specific improvements in respect of the way flows are exchanged between matrix and fracture, governed by capillary, gravitational and viscous forces and compositional mechanisms as well as matrix-to-matrix flow exchanges (dual-permeability, dual-porosity simulators). Several examples of prior art techniques are cited in the reference works listed below.

Thomas, L.K. et al: "Fractured Reservoir Simulation", SPE Journal (February 1983) 42-54;

Quandalle, P. et al: "Typical Features of a New Multipurpose Reservoir Simulator", SPE 16007, presented at the 9th Symposium on reservoir simulation held in San Antonio, Texas, 1-4 February 1987;

Coats, K. H.: "Implicit Compositional Simulation of Single-Porosity and Dual-Porosity Reservoirs", SPE 18427 presented to the SPE Symposium on reservoir simulation held in Houston, Texas, 6-8 February 1989.

One of the problems which reservoir engineers encounter is that of applying parameters to this basic model in order to produce reliable flow predictions. The permeabilities of equivalent fractures and the size of the matrix blocks in particular must be ascertained for each cell of the flow simulator. Whilst the permeability of the matrix can be estimated from cores, there is no simple method of estimating the permeability of the fracture network contained within the cell, i.e. the equivalent fracture permeability, and it is necessary to take account of the geometry and properties of the real fracture network. One method of determining equivalent fracture permeabilities in a fractured network is disclosed in patent application EN.96/16330 filed in parallel with this one.

A reference procedure is known for determining the dimensions a, b of each block of a section crossed by a

regular grid of fractures Feq, which is equivalent to the section of a natural, fractured multi-layered medium crossed by a fracture network FN along a reference plane parallel with the layers (commonly a horizontal or essentially horizontal plane). For each layer of the fractured rock volume studied (figure 1), the "horizontal" dimensions a, b of the blocks of the equivalent section are determined iteratively by means of computations and by comparing the oil recovery functions as a function of time R(t) and Req(t) respectively in the real section RE of the fractured rock volume studied and in the section EQ cut into identically sized "sugar lumps" equivalent to the distribution of real blocks. This conventional method requires a single-porosity multi-phase flow simulator which divides up the matrix blocks and fractures in such a way that the recovery curves can be compared. Such a procedure is extremely costly in view of the fact that the task of dividing up the real section may involve a very high number of cells. The real shape of the blocks in effect have to be represented using thin fracture cells along the boundaries of each block. The matrix also has to be divided up into a large enough number of cells to obtain an accurate block-fracture imbibition transfer function.

Various prior art techniques used in the field are described, for example, in:

- Bourbiaux, B. et al: "Experimental Study of Cocurrent and Countercurrent Flows in Natural Porous Media", SPE Reservoir Engineering (August 1990), 361-368,
- Cuiec, L. et al: "Oil Recovery by Imbibition in Low-Permeability Chalk", SPE Formation Evaluation (September 1994), 200-208.

However, specific imbibition characteristics have never been used as a means of finding the dimensions of the equivalent block in dual porosity models. Reservoir engineers do not therefore have a systematic tool which can be used to calculate the dimensions of parallelepipedic blocks equivalent to multi-phase flows in order to determine the real distribution of the blocks in each fractured reservoir zone.

Techniques for integrating natural fracture data in fractured reservoir models are also known in the prior art. The fracture data are specifically data of a geometric nature and do not incorporate measurements of the density, length, azimuth and tilt of fracture planes, either as observed on outcrops, mine drifts and cores or inferred from well logging. Different fracture sets can be distinguished and characterised by different statistical distributions of their fracture attributes. Once the fracture patterns have been characterised, numerical networks of those fracture sets can be generated using a stochastic method which respects the statistical distributions of fracture

parameters. Such methods are described in patents FR-A-2.725.814, 2.725.794 or 2.733.073, for example, filed by the applicant.

The method of the invention provides a simplified approach to modelling an original geological medium which is heterogeneous and porous (such as a reservoir crossed by an irregular fracture network, for example) in the form of a transposed or equivalent medium in such a way that the transposed medium is equivalent to the original medium as regards a given physical transfer function which is known in the transposed medium. The method consists in:

- forming an image of the geological medium in at least two dimensions in the form of an array of pixels and associating a specific initial value for said function to each pixel in the array,
- determining step by step the value to be assigned to each pixel in the array for the physical transfer function, by reference to the function values assigned to adjacent pixels in the image, and
- determining a physical property of the transposed or equivalent medium by identifying values of the transfer function known for the (simplified) transposed medium with the value determined step by step for the original medium.

The physical transfer function may represent variations between different parts of the geological

medium, variations in distances, transmissivities or heat for example (such as transfers of heat between a reservoir and a well crossing through this reservoir) etc.

The method can be applied as a means of determining from an image of a porous geological medium crossed by an irregular fracture network, for example, a transposed medium comprising a set of regularly arranged blocks separated by a regular grid of fractures, wherein the transposed medium essentially exhibits a same fluid recovery during a process of capillary imbibition as the real medium. This being the case, the method consists in:

- forming an image of the real medium in at least two dimensions in the form of an array of pixels,
- determining for each pixel the minimum distance separating the pixel from the nearest fracture,
- forming a distribution of numbers of pixels based on minimum distances to the fractures and determining the recovery function (R) of said set of blocks on the basis of this distribution and
- determining dimensions (a, b) for equivalent regular blocks in the set on the basis of the recovery function (R) and the equivalent recovery function (Req) (using a procedure to identify said recovery functions, for example).

With the method defined above based on a pixel representation of the medium, a number of different transfer functions applied to any type of heterogeneous medium can be easily and rapidly computed.

The geometric method, for example, determines the dimensions of equivalent blocks, providing a very good match of the imbibition behaviour of the real block or the distribution of real blocks, regardless of the shape (or shapes) of the blocks in question. Although simplified compared with the methods of the prior art, the oil recovery curve plotted for the equivalent section of the block has proved to be very close to that plotted for the real block.

Other features and advantages of the method of the invention will become clearer from the following description of embodiments, given by way of example and not restrictive in any respect, and with reference to the appended drawings, of which:

figure 1 illustrates a known procedure used to determine a medium having regular fractures equivalent to the real fractured medium,

figure 2 illustrates the procedure of the invention which allows a medium having regular fractures equivalent to a real fractured medium to be determined,

figure 3 shows an example of adjacent pixels used to compute the value assigned to a pixel,

figure 4 is a histogram of a possible distribution of pixels in relation to distance from fractures,

figure 5 is one possible variation in a normalised invaded area as a function of distance to fractures,

figure 6 shows another example of adjacent pixels in three different planes, Sk-1, Sk and Sk+1 for a 3D computation of values attributed to a pixel,

figure 7 shows how adjacent pixels can be extended in order to improve the computation of values attributed to a pixel and

figure 8 shows, for the purpose of validation, how good a match is obtained for two oil recovery curves OR(t) determined using a real "comb-shaped" block on the one hand and an equivalent rectangular block on the other.

A new simplified procedure which can be used to compute the dimensions of the block section equivalent to the "horizontal" section of a natural fractured medium is explained below.

It should first of all be pointed out that according to the "vertical" fracture hypothesis, i.e. perpendicular to the stratification planes, the matrix medium is continuous from one geological layer to another and the problem inherent in finding equivalent block dimensions becomes a two-dimensional one. Consequently, the problem faced in this instance is that of determining the equivalent square or

rectangular surface area of numerical matrix blocks for each layer or group of layers exhibiting similar fracture properties.

Secondly, the equivalence of a dual porosity model relative to a fractured model has to be established in terms of flow behaviour. The flows occurring within fractured oil reservoirs during field exploitation are essentially multi-phase and there are two main drive mechanisms as regards oil recovery from the matrix, capillary imbibition and gravity drainage. The effects of these two mechanisms are combined in the oil recovery methods which predominate as a strategy for developing many fractured reservoirs. Compositional mechanisms such as diffusion represent another factor inherent in the methods used to recover gas. It is for this reason that the geometric method described below as a means of determining equivalent blocks is based on the concepts of multi-phase flow.

An embodiment of the invention is described below with reference to figure 2, which consists in essence in matching the oil recovery function R(t) (of the natural fractured medium) obtained by the above-mentioned reference method with the known recovery function Req(t) of the transposed medium in relation to a two-phase oil-water imbibition process (during a water-oil capillary imbibition drive process). This matching is applied to each layer of the fractured

medium and then for sets of n layers. In this case, the recovery function R(t) obtained is the sum of the different functions Rn(t) of the n layers weighted by the corresponding thicknesses Hn. Since the fractures are vertical, only the horizontal dimensions of the equivalent block are determined. The task of matching the functions R(t) and Req(t) is therefore a two-dimensional one.

1 Geometric formulation

Since the fractures are defined by the coordinates of their boundary points on a two-dimensional section XY of a layer, the imbibition process by which water is present in the fractures and oil is present in the matrix blocks must be determined. It is assumed that the penetration of the matrix by the water is of the piston type. It is assumed that the function x=f(t) which links the advancing movement of the water front over time is the same for all the matrix blocks, irrespective of their shape, and for all the elementary blocks. Consequently, fitting the functions R(t) and Req(t) is equivalent to fitting the functions R(x) and Req(x). These functions physically define normalised zones penetrated by water as a function of the forward movement of the imbibition front through the fractured medium.

In 2D, the analytical expression of Req(x) is as follows:

$$\begin{cases} \operatorname{Re}q(x) = 1 - \frac{1}{a \times b}(a-2x)(b-2x) = 2\left(\frac{1}{a}+\frac{1}{b}\right)x - \frac{4}{a \times b}x^2, x \in \left[0, \min\left(\frac{a}{2}, \frac{b}{2}\right)\right] \\ \operatorname{Re}q(x) = 1, x > \min\left(\frac{a}{2}, \frac{b}{2}\right) \end{cases}$$

where a and b are the dimensions of the equivalent rectangular or square block (a and b > 0):

The function R(x) does not have an analytical expression. It is computed by dividing up the section XY of the layer studied in accordance with the algorithm defined below.

2 Algorithm used to compute the function R(x)

The section XY of the layer studied is considered as being an image in which each pixel represents a surface element. The pixels are regularly spaced apart at a pitch dx in the direction X and dy in the direction Y. The algorithm used is intended to determine for each pixel in this image the minimum distance which separates it from the nearest fracture.

The image is translated by a table of two-dimensional real numbers: Pict[0:nx+1.0:ny+1] where nx and ny are the numbers of pixels in the image in the directions X and Y. In practice, the total number of pixels is in the order of one million, for example. The values of elements in the Pict table are the distances sought.

Initialisation : All the pixels through which a fracture passes are at a distance zero from the closest fracture. The Pict table for these pixels is therefore initialised at value 0. This is done using a known algorithm (the Bresline algorithm, for example) to which are attributed the coordinates of pixels corresponding to the two ends of a fracture considered as a segment of a line and which initialises (at 0 in this specific case) the nearest pixels. The other elements of Pict are initialised at a value greater than the longest distance which exists between two pixels of the image. This value is nx.dx+ny.dy, for example.

Computation : The required distance of a given pixel from the closest fracture is computed on the basis of the distance values already calculated for the adjacent pixels. A value is assigned to it which, if it proves to be lower than the value initially assigned to it, is the minimum of the values of adjacent pixels to which is added the distance of these pixels from the one being considered.

This computation is performed in two successive phases. During the descending pass, the image is scanned line by line from top to bottom and from left to right (from Pict [1,1] to Pict [nx,ny]). The pixels taken into account therefore differ depending on whether a descending pass or an ascending pass is being

run. As can be seen from figure 3, the black and shaded pixels are those which will be taken into account respectively during the descending passes and ascending passes for the pixel Px.

The oblique distance dxy being defined as : $dxy = \sqrt{dx^2 + dy^2}$, the algorithm is written

```
  where j=1 to ny
| where i=1 to nx
| |  Pict[i,j]=  min  Pict[i-1,j]+dx,   :descending pass
| |                   Pict[i-1,j-1]+dxy,
| |                   Pict[i,j-1]+dy,
| |                   Pict[i+1,j-1]+dxy,
| |                   Pict[i,j]
| end of loop on i
end of loop on j

  where j=ny to 1,
| where i=1x to 1,
| |  Pict[i,j]=minPict[i+1,j]+dx,      :descending pass
| |                   Pict[i+1,j+1]+dxy,
| |                   Pict[i,j+1]+dy,
| |                   Pict[i-1,j+1]+dxy,
| |                   Pict[i,j]
| end of loop on i
end of loop on j
```

Histogram : From the table Pict calculated in this manner, a histogram can be plotted by classifying the non-zero values (those assigned to the pixels outside the fractures) by ascending order.

The cumulated result of this histogram gives, for any distance delimiting two intervals of the histogram, the number of non-zero pixels whose value is less than this distance. When the method described is applied to a fractured porous medium where this distance corresponds to the advancing water front, the cumulated result of the histogram therefore indicates the area penetrated by water. The curve R(x) is obtained by dividing this cumulated result by the total number of non-zero pixels (to standardise it). The number of intervals used on the abscissa of the histogram will correspond to the number of dividing points on the curve R(x). It may be chosen as being equal to 500, for example.

3 Finding the equivalent block dimensions

At this stage, the function R(x) is known and it is now necessary to find the parameters $(\overline{a},\overline{b})$ (dimensions of the equivalent block which minimise the functional):

$$J(a,b)=\sum_{i=1}^{N}\left(R(x_i)-\mathrm{Re}q-a,b,x_1)\right)^2$$

where N is the number of dividing points of R(x) and (x_i) are the abscissa of these dividing points.

Division along the ordinate of R(x):

In order to give the same weight to all the volumes of oil recovered during imbibition, the curve R(x) is re-divided at a constant pitch along the axis of the ordinates (figure 5). The sequence (x_i) used by the functional is deduced from this division.

Minimisation of the functional :

Since a and b play symmetrical parts in the expression Req(a,b,x), the following functional is actually used:

$$\mathcal{J}(u,v) = \sum_{i=1}^{N}\left(R(x_i) - \mathrm{R}\tilde{e}q(u,v,x_i)\right)^2$$

where $\begin{cases} \mathrm{R}\tilde{e}q(u,v,x) = u \times x + v \times x^2 \\ \mathrm{R}\tilde{e}q(u,v,x) \leq 1 \end{cases}$, i.e. $\begin{cases} u = 2 \times \left(\frac{1}{a} + \frac{1}{b}\right) \\ v = \frac{-4}{a \times b} \end{cases}$

Minimising this function amounts to finding the pair $(\bar{u},\bar{v})$ for which $\mathcal{J}'(\bar{u},\bar{v}) = 0$. This is done by a Newton algorithm.

Then, the pair $(\bar{a},\bar{b})$ which is sought is derived from $(\bar{u},\bar{v})$. Three situations may arise:

1) $\bar{v} > 0$ means that one of the values of the pair $(\bar{a},\bar{b})$ is negative, which does not make sense physically speaking. v=0 is then incorporated in the expression of $\mathrm{R}\tilde{e}q(u,v,x)$, which means that the fractures are parallel.

The operation is repeated and the pair $(\bar{a},\bar{b})$ is computed as follows:

$$\begin{cases} a = \dfrac{2}{\bar{u}} \\ \bar{b} \inf ini \end{cases}$$

2) The case $\bar{u}^2 + 4\bar{v} < 0$ does not make any physical sense either since it means that $(\bar{a},\bar{b})$ are not real. If we let $u^2+4v=0$, this will impose a factor whereby the elementary block sought is square shaped (a=b). After minimisation, the pair $(\bar{a},\bar{b})$ is computed as follows:

$$\begin{cases} \bar{a} = \dfrac{4}{\bar{u}} \\ \bar{b} = \bar{a} \end{cases}$$

3) For the other values of the pair $(\bar{u},\bar{v})$, we have:

$$\begin{cases} \bar{a} = \dfrac{-\bar{u} + \sqrt{\bar{u}^2 + 4\bar{v}}}{\bar{v}} \\ \bar{b} = \dfrac{-\bar{u} - -\sqrt{\bar{u}^2 + 4\bar{v}}}{\bar{v}} \end{cases}$$

4 Validation of the method of determining an equivalent block

The geometric method outlined above for an imbibition transfer function was validated relative to a conventional and very costly reference method which requires a single-porosity multi-phase flow simulator

to divide the matrix blocks and fractures up in a manner allowing the recovery curves to be compared. Conventional two-phase flow simulations were run in order to validate the solutions provided by the geometric method described above. The validation may incorporate the following steps:

a) computing the oil recovery function R(t) for the (real) geological section using the conventional method (reference solution);

b) applying the geometric method to the real section, which gives a solution (a,b);

c) using the conventional method again, computing the oil recovery function Req(t) on the equivalent block section having dimensions (a,b) determined beforehand and effecting a comparison with the oil recovery function of reference R(t).

The geometric method gives equivalent block dimensions which enable a very good match of the imbibition behaviour of the real block, regardless of the shape of the block being considered. The oil recovery curve computed on the equivalent block section is always very close to that calculated for the section of the real block, as illustrated in figure 8.

The same validation was also successfully performed for a distribution of blocks exhibiting other different dimensions and shapes.

5 Other applications of the method

Accuracy of the computed distances to fractures

In the algorithm used to compute the distances of the pixels to the fractures on the basis of the 2D image, the accuracy of the computation can be improved by taking into account a larger number of pixels adjacent to the one being studied. Figure 7 shows the adjacent pixels taken into account when the influence of a pixel Px is extended to two lines and two columns before or after the pixel Px. Similarly, the black and shaded pixels are those which will be taken into account respectively during the descending passes and ascending passes, whilst those shown by a cross will be eliminated as they are redundant.

To increase the accuracy of the computations still further, the zone of influence of the pixels could be extended still further (to 3 lines and 3 columns or more). In practice, however, for the application presented above, such an extension does not impart any significant improvement to the final results.

Extending the method to a three-dimensional object

The algorithm givem above can be applied to a volume. In this case, each pixel represents an element of volume. The table Pict is replaced by a 3-dimensional table Pict3D[0:nx+1.0:ny+1.0:nz+1] where nx, ny and nz are the numbers of pixels along X, Y and Z. The adjacent pixels taken into account during the

descending and ascending passes in order to compute the horizontal plane number k at a pixel Px are illustrated in figure 6.

Extending to any function

In the example that has been developed in relation to the study of two-phase imbibition (water-oil, for example), the aim is to determine the sizes of the blocks in relation to the distance of points to the nearest fracture. The geometric method of the invention can also be used for other types of transfers between two contrasting media, such as transfers of heat between a well and a reservoir, for example. Above all, however, the "distance between pixels" function used in the algorithm above can be replaced by any function which links the points of an image. The value of this function between this pixel and its adjoining pixels taken into account for the purposes of the computation will have to be known for every pixel in the image. This function may express the transmissivity values between the grids of a reservoir, for example, the centres of which are the pixels of the image that will be used to calculate the drainage volume of a well bored through this reservoir.

In one such situation, the two ascending and descending passes performed in the algorithm may not prove adequate for the purposes of finding a minimum

value at any pixel of the image. The operation will therefore be repeated until the computed values no longer change.

By using the notations presented above and assuming that the function F(i,j,k,l) will return the value of the function between the pixels (i,j) and (k,l), the 2D algorithm becomes:

```
   change=true
as long_as(change==true)
   change=false
where j=1 to ny
|  where i=1 to nx
| |  temp=Pict[i,j]
| | Pict[i,j]=min(Pict[i-1,j]+F(i,j,i-1,j),  :descending
                                                pass
| |              Pict[i-1,j-1]+F(i,j,i-1,j-1)
| |              Pict[i,j-1]+F(i,j,i-1,j-1)
| |              Pict[i+1,j-1]+F(i,j,i+1,j-1)
| |              Pict[i,j]
| |   if (Pict[i,j]<>temp)change=true
| end of loop on i
end of loop on j

  where j=ny to 1,-1
| where i=nx to 1,-1
| |  temp=Pict[i,j]
| |     Pict[i,j]=min(Pict[i+1,j]+F(i,j,i+1,j),
```

```
                                : ascending pass
| |                 Pict[i+1,j+1]+F(i,j,i+1,j+1)
| |                 Pict[i,j+1]+F(i,j,i,j+1)
| |                 Pict[i-1,j+1]+F(i,j,i-1,j+1)
| |                 Pict[i,j]
| |  if (Pict[i,j,]<>temp change=true
| end of loop on i
end of loop on j
as long_as
```

CLAIMS

1. A method of simplifying the task of modelling an original, heterogeneous, porous geological medium in the form of a transposed or equivalent medium such that the transposed medium is equivalent to the original medium relative to a given type of physical transfer function which is known in respect of the transposed medium, the method consisting in:

- forming an image of the geological medium in at least two dimensions (2D) in the form of an array of pixels and associating a specific initial value for said function to each pixel in the array,
- determining step by step the value to be assigned to each pixel in said array for the physical transfer function, by reference to values of the function assigned to adjacent pixels in the image, and
- determining a physical property of the transposed or equivalent medium by identifying the volume of the transfer function known for the transposed medium with the value of the transfer function determined step by step for the original medium.

2. A method as claimed in claim 1, characterised in that the heterogeneous geological medium is crossed by an irregular network of fractures, all geometrically defined in blocks of irregular shapes and sizes.

3. A method as claimed in one of claims 1 or 2, characterised in that said physical transfer function

represents a distance between different parts of the geological medium.

4. A method as claimed in one of claims 1 or 2, characterised in that said physical transfer function represents transmissivities between different parts of the geological medium.

5. A method as claimed in one of claims 1 or 2, characterised in that said physical transfer function represents thermal transfers between different parts of the geological medium such as transfers of heat between a reservoir and a well crossing through this reservoir.

6. A method as claimed in one of claims 1 or 2, characterised in that said physical transfer function represents any transfer of mass or flow between different parts of the geological medium.

7. A method as claimed in claim 2, used to determine, from an image of a real porous geological medium crossed by an irregular network of fractures, a transposed medium comprising a set of blocks arranged regularly and separated by a regular grid of fractures, said transposed medium essentially giving the same fluid recovery (Req) during a capillary imbibition process as the real medium, the method consisting in:

- forming an image of the real medium in at least two dimensions (2D) in the form of an array of pixels,

- determining for each pixel the minimum distance separating the pixel from the closest fracture,

- forming a distribution of the number of pixels based on the minimum distance to the fractured medium and determining the recovery function (R) of said set of blocks on the basis of this distribution and

- determining dimensions (a, b) for equivalent regular blocks in the transposed medium on the basis of the recovery function (R) and the recovery function (Req) of the equivalent block.

8. A method as claimed in any preceding claim and substantially as hereinbefore described with reference to figures 2 to 8 of the accompanying drawings.

The Patent Office

20

Application No:	GB 9727231.4	**Examiner:**	Mike Davis
Claims searched:	1-8	**Date of search:**	2 July 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G4A (AUA, AUXX)

Int Cl (Ed.6): G06F, G06G, G01V

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	EP 0211683 A2 (SCHLUMBERGER)	1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.